SPACE TUG AUTOMATIC DOCKING CONTROL STUDY

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LOCDOK USERS MANUAL

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LOCDOK/SPACE TUG DOCKING SIMULATION

USERS MANUAL

Prepared for -

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(Contract NAS 8-29747)

LOCKHEED MISSILES & SPACE COMPANY

FOREWORD

The LOCDOK Users Manual was prepared for the Aero-Astrionics Laboratory, Marshall Space Flight Center, by Lockheed Missiles & Space Company under Contract Number NAS8-29747. LOCDOK, prepared under the direction of Mr. Mario H. Rheinfurth, Principal COR and Mr. Homer C. Pack, computer-simulates the dynamics of automatic docking and the operations of the Space Tug performing this type of mission.

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Section 1

TECHNICAL INFORMATION

1.1 PURPOSE AND THEORY

This manual contains the information required to run LOCDOK.

For the user who finds it mandatory to set up a run of LOCDOK before doing an in-depth study of the program, it is recommended that he give study to Section 2, Usage Information, and to Appendix A, LOCDOK Input Dictionary. The basic information given in these two sections is sufficient to set up a run. If problems occur, the program input should be checked first. If the input is correct and the problem persists, it is possible that the run has imposed an unknown constraint on the program. To track down this constraint, the user must now expand his study of this manual and should peruse Section 1, Technical Information, or, for greater depth, make use of pertinent documents listed in Section 3, References.

Section 1 is composed of four subsections which will help the user in correcting problems. These subsections deal with the following topics:

- o Subroutine narratives
- o Program elements
- o System subroutines
- o Univac 1108 cross reference listing

1.2 MATHEMATICAL/NONMATHEMATICAL MODEL

See References, Section 3.

1.3 COMPUTER CONFIGURATION

1.3.1 Hardware Information

The hardware requirements for the Univac 1108 computer is defined in Section 2.1 of this manual.

1.3.2 Coding Information

The program was coded in Fortran V, using a standard systems library. LOCDOK has two packages which are "system peculiar". They are as follows:

- o The plot package, because of its use of NTRAN on the Univac 1108.
- o The input package because of its character interrogation and conversion.

1.3.2.1 Program Elements

Table 1-1 contains a cross reference of the elements in the Univac 1108 version of LOCDOK.

1.3.2.2 System Subroutines

Table 1-2 lists all system subroutines used by the Univac 1108 version of LOCDOK.

Table 1-1

LOCDOK Cross-Reference

Table

ELEMENT	ENTRY POINT	REFERENCING ELEMENTS	EXTERNAL SYMBOL
AREL/CODE	ADREL	EXEC4/CODE	

```
@XREF,XREF,XREF TPF$,
 XREF OF FILE 603479*TPF$
 ACQ            01 (001475) (ACQ) ,DOCK
 ADREL          01 (000276) (ADREL) ,EXEC4,SUPER
 ATUDE          01 (001420) (ATUDE) ,EXEC4,BURNP
 AVDATA         01 (000032) (AVDATA) ,AVION1,AVDATM
 AVDATM         01 (000442) (AVDATM) ,AVION1
 AVION1         01 (000034) (AVION1) ,MONITR
 AVION2         01 (000233) (AVION2) ,AVION3,MONITR
 AVION3         01 (000141) (AVION3) ,AVION2,MONITR
 BMW            01 (000303) (BMW) ,ACQ,CHAND,PATCH,INTCR,JUMBO,KMAN
 BLOCK1         01 (000004) (BLOCK1) ,PLOTOP
 BURNP          01 (001065) (BURNP) ,CHAND
 CARDS          01 (000135) (CARDS) ,PLOTOP
 CHAND          01 (002542) (CHAND) ,EXEC4,DOCK,SUPER
 CROSS          01 (000037) (CROSS) ,ORBITA,MATCHP
 CROSSP         01 (000034) (CROSSP) ,FATAX2,RELK2,ADREL,WHIZ,FATPT,CRS2,GCORR,DOCK,TIGHT,KMAN
 CRS2           01 (000237) (CRS2) ,DOCK
 CURE           01 (001654) (CURE) ,FATPT
 DAN            01 (000347) (DAN) ,WHIZ,PATCH,JUMBO
 DELTAS         01 (000224) (DELTAS) ,ELCON
 DOCK           01 (007500) (DOCK) ,TERMER
 DOT            01 (000624) (DOT) ,ORBITA,RELK2,ADREL,CHAND,RELKIN,KEPLER,MATCHP
 DOTSP          01 (000023) (DOTSP) ,FATAX2,EXEC4,BURNP,RELK2,ADREL,ACQ,ATUDE,CURE,FATPT,CRS2,GCORR,DOCK,TIGHT
                                    ,INTCR,KMAN,GCRV,FINCR
 ELCON          01 (000660) (ELCON) ,WHIZ,PATCH
```

TABLE 1-1 (Cont'd)

```
EXEC4      01 (000605) (EXEC4) ,TERMEX,JUMBO
FATAX2     01 (001622) (FATAX2) ,DOCK
FATPT      01 (002014) (FATPT) ,TERMEX,DOCK
FINCR      01 (000346) (FINCR) ,FATAX2,FATPT,DOCK
FINISH     01 (000052) (FINISH) ,BURNP,ATUDE
FITDAT     01 (000336) (FITDAT) ,SUPER
FLD        01 (000031) (FLD) ,INPUT,NIPS
GATHR      01 (000975) (GATHR) ,EXEC4,SUPER
GAUSS      01 (000325) (GAUSS) ,EXEC4,SUPER
GCORR      01 (002213) (GCORR) ,FATPT,INTCR
GCRV       01 (000331) (GCRV) ,FATAX2,FATPT,GCORR,DOCK,INTCR
GOLD2      01 (000550) (GOLD2) ,WHIZ,PATCH
GUESS      01 (000145) (GUESS) ,GOLD2
HEST       01 (000463) (HEST) ,KMAN
INPUT      01 (000560) (INPUT) ,AVION2
INTCR      01 (002516) (INTCR) ,FATPT,DOCK
INTEG      01 (000126) (INTEG) ,GATHR,BURNP,ATUDE
INVERS     01 (000674) (INVERS) ,HEST,KMAN
JAKE       01 (000023) (JAKE) ,EXEC4,BURNP,ATUDE,CHAND,SUPER
JUMBO      01 (001552) (JUMBO) ,AVION3
KEPLER     01 (000447) (KEPLER) ,BURNP,ATUDE,FATPT,DOCK,RVTOC,JUMBO
KMAN       01 (001762) (KMAN) ,SUPER
LBLTRC     01 (000233) (LBLTRC) ,PLOTOP
LIMITS     01 (001211) (LIMITS) ,PLOTOP
MATCHP     01 (000110) (MATCHP) ,ATUDE,CURE,RVTOC2,RVTOC
MPFIX      01 (000052) (MPFIX) ,LIMITS
MTXA       01 (000032) (MTXA) ,BURNP
MTXASP     01 (000031) (MTXASP) ,RELK2,ATUDE,INTCR
MXA        01 (000635) (MXA) ,RVTOC2,RVTOC
MXASP      01 (000034) (MXASP) ,INTCR
NAD        01 (000301) (NAD) ,WHIZ,PATCH
NIPS       01 (001661) (NIPS) ,INPUT

NOISE      01 (000603) (NOISE) ,GAUSS,JUMBO
ORBITA     01 (000524) (ORBITA) ,EXEC4,BURNP,FATPT,DOCK,INTCR,JUMBO,SUPER
OUTPT3     01 (002635) (OUTPT3) ,FATAX2,EXEC4,BURNP,FATPT,CHAND,DOCK,FINCR
OVERLP     01 (000160) (OVERLP) ,PLOTOP
PATCH      01 (001614) (PATCH) ,JUMBO
PCOMP      01 (000654) (PCOMP) ,ORBITA
PLOTOP     01 (000763) (PLOTOP) ,AVION2
PLTPG      01 (000210) (PLTPG) ,CHAND
RANDM      01 (000155) (RANDM) ,GAUSS,NOISE
READY      01 (000107) (READY) ,PLOTOP,LIMITS,OVERLP
RELKIN     01 (000052) (RELKIN) ,CURE,DOCK
RELK2      01 (000272) (RELK2) ,EXEC4,BURNP,CHAND,JUMBO,SUPER
RETRO2     01 (000224) (RETRO2) ,DOCK
ROTMT      01 (000142) (ROTMT) ,ATUDE
RVTOC      01 (000164) (RVTOC) ,CURE,DOCK,SUPER
RVTOC2     01 (000171) (RVTOC2) ,BURNP,RELK2
SCLGRD     01 (000254) (SCLGRD) ,PLOTOP
SETUPP     01 (000122) (SETUPP) ,PLOTOP
SUPER      01 (001711) (SUPER) ,FATAX2,CURE,FATPT,GCORR,DOCK,INTCR
TERMEX     01 (000104) (TERMEX) ,JUMBO
TESTER     01 (000321) (TESTER) ,DOCK
TIGHT      01 (000101) (TIGHT) ,FATAX2,FATPT,DOCK
WHIZ       01 (000137) (WHIZ) ,ACQ,GCOMP,INTCR,KMAN
WRIDAT     01 (000171) (WRIDAT) ,PLTPG,AVION2,AVION3
WRIT25     01 (000072) (WRIT25) ,WRIDAT
```

Table 1-2

UNIVAC 1108 LIBRARY AND SYSTEM ROUTINES

ALOG$
APRINTV
ASINCOS$
ATAN$
BUFRV$
CAMRAV
CPLOT$
SATAN$
DATE
DSHLNV
DSINCOS$
DSQRT$
DVDYV
EDIT$
ERMRKV
ERRLNV
ERRNLV
ERU$
ETOD$
EXP$
GETPUT
GRAC$
GRID1
HOLLV
IDFRM$
KOMPAR
LABLV
LINEV
LINRV

NBOO$
NEXP5$
NEXP6$
NIBUF$
NININ$
NINPT$
NOBUF$
NONLNV
NOSYM$
NOTIN$
NTRAN
PLOTV
PLOT$
PLOT$$
PRINTV
RITE2V
SCCTAB
SCD01
SCD02
SINCOS$
SMXYV
SPILLS
SORT$
TABL1V
TANCOTAN$
VCHARV
VLAGM
SCALV

1.4 SUBROUTINE DESCRIPTIONS

This section contains narrative descriptions, in alphabetical order, of each of the subroutines used by the Univac 1108.

1. ACQ

Subroutine ACQ generates data to enable pointing of the ranging sensor at the payload prior to acquisition and lock-on. Ten sets of range, angles, and time are provided: 5 sets prior to nominal acquisition range,

1 set at nominal acquisition range, and

4 sets between nominal acquisition range, and

the calculated time of nearest approach. At nominal acquisition range, state vectors for tug and payload are generated and outputted for the start of the rest of the program.

2. ADREL

Subroutine ADREL computes kinematic variables such as range, range rate, and two angular rotation rates; and tabulates the transformation from inertial to tracker coordinate systems for the proportional guidance simulation.

3. ATUDE

Subroutine ATUDE simulates the detailed attitude control system, vehicle body rates, and the transformation from the body frame to the inertial frame. The following parameters are included in the detailed attitude control system:

- Rate and position gains
- Torque saturation and deadband
- Torque lab
- Control moment
- Moments of inertia

Additional documentation is provided in Ref. 4.

4. AVDATA

Subroutine AVDATA presets to the value shown in the input dictionary all data to be input to the LOCDOK program.

5. AVDATM

Subroutine AVDATM is used to operate program in metric units. It calls AVDATA and then converts dimensional quantities (speed, distance, force, and mass) to metric units.

6. AVION1

AVION1 is the driver for the 1108 version.

7. AVION2

From AVION2 all data are input, and the SC-4020 plot tape is made. The functions performed by this subroutine are specified by input data.

8. AVION3

AVION3 controls all engineering calculations.

9. BHW

Subroutine BHW calculates the transformation from an inertial system to the orbital system. Additional documentation is provided in Ref. 2.

10. BLOCK1

Subroutine BLOCK1 contains as preset data statements the labels of the curves generated by the LOCDOK plot package.

11. BURNP

Subroutine BURNP calculates the trajectories of the Tug, the payload, and the tug-centered relative motion.

Additional documentation may be found in Ref. 4.

12. CARDS

Subroutine CARDS stores plot package input data, which input cards have preset or over-read into the I block of blank common input data, in properly labeled common blocks for use by the plot package.

13. CMAND

Subroutine CMAND calculates the engine switching logic for commanding the thrust of the engines. The subroutine also calculates the vehicle thrusting direction.

14. CROSS

Subroutine CROSS calculates the double-precision cross product between two double precision input vectors:

(where vectors AV and BV are inputs and vector DV is an output.)

15. CROSSP

Subroutine CROSSP calculates the cross product between two single precision vectors:

$$DSPV = ASPV \times BSPV$$

(where vectors ASPV and BSPV are inputs and vector DSPV is an output).

16. CRS2

Subroutine CRS2 selects a final position (R_{S_2}) to be reached in fast-transfer-to-an-axis and docking maneuvers in the terminal rendezvous maneuver programming.

Additional documentation is provided in Ref. 4

17. CURE

In terminal rendezvous maneuvers, tracking data must ensure that a point-to-point transfer can be commanded with good accuracy. Subroutine CURE performs an approximate test on the tracking data-taking rate input and controls the spacing of the given number of data points chosen. Details of this logic are presented in Ref. 5.

18. DAN

Subroutine DAN converts the inertial position and velocity of a satellite to a set of instantaneous orbit elements. If the second and all higher

18. DAN (Cont.)

zonal harmonics of earth's gravitational field are assumed to be zero, then the instantaneous orbit elements are keplerian orbit elements.

Source equations are given in Ref. 2.

19. DELTAS

Subroutine DELTAS calculates the orbit element increments required to convert from mean orbit elements to instantaneous orbit elements or from instantaneous orbit elements to mean orbit elements.

20. DOCK

Subroutine DOCK controls the computations needed to transfer the Tug to a given docking axis of the payload, take the Tug down the docking axis to a given standoff range, and, finally, to impart a given docking velocity to the docking maneuver. Actual fast transfer computations are performed elsewhere by subroutine FATPT.

Additional documentation is provided in Ref. 4.

21. DOT

Subroutine DOT calculates the double-precision dot product of two double precision input vectors:

$$C = AV \circ BV$$

22. DOTSP

Subroutine DOTSP calculates the single-precision dot product of two single-precision input vectors:

$$CSP = ASPV \circ BSPV$$

23. ELCON

Subroutine ELCON converts from instantaneous to mean orbit elements, or from mean to instantaneous orbit elements. It also calculates the constants required by GOLD2 to move the mean orbit elements either forward or backward in time.

Additional documentation is provided in Ref. 2.

24. EXEC4

Subroutine EXEC4 is the executive driver of the proportional guidance section It initializes certain program variables and resets others based on input information in blank common.

EXEC4 is also responsible for the termination of the proportional guidance mission. Additional documentation is provided in Ref. 4.

25. FATAX2

Subroutine FATAX2 is the executive driver for the fast-transfer-to-an-axis maneuver.

Source equations and logic are given in Ref. 4.

26. FATPT

Subroutine FATPT contains the executive logic for the gross correction, intermediate corrections, and final corrections of the fast transfer maneuver.

Additional documentation is provided in Ref. 4.

27. FINCR

In terminal rendezvous maneuvers intended to end with zero relative motion between payload and tug, a small separate subroutine was devised to command a burn equal to and opposite the prevailing relative velocities. Subroutine FINCR provides the necessary calculations.

Additional documentation is provided in Ref. 4.

28. FINISH

Subroutine FINISH and subroutine INTEG comprise the Runge-Kutta integration package used in LOCDOK.

29. FITDAT

Subroutine FITDAT performs linear data fitting or smoothing by accumulation.

Additional information may be found in Ref. 4.

30. FLD

Subroutine FLD is used to relay arguments to the 1108 system GETPUT routine. Its calling sequence is:

Call FLD (XX, II, JJ, KK, YY)

where

XX = word to which bits will be transferred

II = bit number to start storing bits in XX

JJ = number of bits transferred

KK = bit number to start taking bits from YY

YY = word from which bits are transferred

The local variables for this subroutine are as follows:

I = first bit position of bits of 1108 word to be transferred

J = last bit position of bits of 1108 word to be transferred

K = first bit position of 1108 word where bits are to be stored

L = last bit position of 1108 word where bits are to be stored

31. GATHR

Subroutine GATHR incorporates filtering (from the guidance filters other than the Kalman) noise, bias, and resolution to the uncorrupted data.

Additional documentation is presented in Ref. 4.

32. GAUSS

Subroutine GAUSS generates the corruption due to noise that will be added to the data in subroutine GATHR. Eight sepate range-dependent, colored-noise generators contained in GAUSS are used to corrupt sensor data.

Additional documentation is provided in Ref. 4.

33. GCORR

Subroutine GCORR computes an engine burn that would start the Tug toward a desired final position allowing for displacement while thrusting. This subroutine is one of the key elements of the new "fast-transfer-to-a-point" logic.

34. GCRV

Subroutine GCRV is used in the data taking and fitting scheme where it performs a linear extrapolation of the position and velocity of the Tug in payload orbital coordinates, over a time interval specified in the subroutine.

Additional documentation is provided in Ref. 4.

35. GOLD2

Subroutine GOLD2 advances the close-form mean orbit elements by some increment of time.

36. GUESS

Subroutine GUESS performs a preliminary estimate of the advanced mean anomaly. This estimate is then refined by GOLD2 for mean orbit elements.

Additional documentation is provided in Ref. 2.

37. HEST

Subroutine HEST performs Kalman filtering by use of equations appearing in Ref. 11.

38. INPUT

Subroutine INPUT reads input cards in alphanumeric format. It interprets the letter (A through Z) in the first column of a card to determine the location in blank Common which corresponds to the first location of the data block in which the control data are stored. INPUT then interprets the next field on the card. This field gives the relative address (within the data block specified in the preceding field) of the first word of the control data in the free-format field (columns 9 through 80). At this point, INPUT calls subroutine NIPS to interpret the free-format portion of the control card and store the information in the proper common location. The interpreted card is then printed out and the next card is read.

The calling sequence of INPUT has only one argument, NBA, which is returned to the calling routine to indicate whether another card other than an END card follows in a set. All other local variables used by INPUT are described in Ref. 5.

39. INTCR

Subroutine INTCR performs midcourse guidance computations in fast-transfer-to-a-point maneuvers in LOCDOK. The present coding differs from that originated by ITTRI in Ref. 4 in that it is assumed that the duration of the burn at the end of the fast transfer may be long and non-negligible.

INTCR is based on the equations and logic presented in Ref. 5.

40. INTEG

Subroutine INTEG and subroutine FINISH comprise the Runge-Kutta integration pac package.

41. INVERS

Subroutine INVERS inverts an N-by-N matrix and restores the inverted matrix to the locations of the input matrix.

42. JAKE

Subroutine JAKE is called to initialize certain integration constants for INTEG. It must be called every time one of these constants is changed.

43. JUMBO

Subprogram JUMBO is the driver which controls both the terminal maneuver and the proportional guidance sections of LOCKOK.

44. KEPLER

Subroutine KEPLER, when given a value of simulation time and a set of orbital elements, computes payload and/or Tug position and velocity vectors in the earth-centered inertial coordinates.

The computations are performed in double precision by Newton-Raphson interation or Kepler's Equation for the eccentric anomally.

When the integer argument is 1, the tug position and velocity are computed; when the argument is 2, the payload position and velocity are computed and, when the argument is 3, the positions and velocities of both are computed.

45. KMAN

Subroutine KMAN is the link between the Kalman filter in subroutine HEST and the rest of the program. It receives corrupted measurements, generates nominal values of the measurements, forms the residuals, generates the transistion matrix, the data weighting matrix, calls HEST, and links the output of HEST to the rest of the program.

46. LBTRC

Subroutine LBTRC drives the routine that labels the curves on the SC-4020 plots.

This subroutine is part of the plot package. Additional information is provided in Ref. 5.

47. LIMITS

Subroutine LIMITS searches the input data tape to find the maximum and minimum of all the parameters to be plotted.

This subroutine is part of the plot package. Additional documentation is provided in Ref. 5.

48. MATCMP

Subroutine MATCMP, given an initial position and velocity vector, computes the orbital coordinate transformation matrix in double precision. The first two arguments of the calling sequence are the position and velocity vectors, respectively. The third argument is a 3-by-3 array containing the transformation matrix.

Additional information is provided in Ref. 4.

49. MPFIX

MPFIX modifies the scale factors calculated by the plotting routines. The scale factors are rounded down to the nearest 1×10^n, 2×10^n, or 5×10^n where n is a positive integer.

50. MTXA

Subroutine MTXA takes the product of a transposed double-precision matrix (first argument) by a double-precision vector (second argument). The double-precision result is returned as the third argument.

51. MTXASP

Subroutine MTXASP takes the product of a transposed single precision matrix (first argument) by a single precision vector (second argument). The single precision result is returned as the third argument.

52. MXA

Subroutine MXA takes the product of a double-precision matrix (first argument) by a double-precision vector (second argument). The double-precision vector result is returned as the third argument.

53. MXASP

Subroutine MXASP takes the product of a single-precision matrix (first argument) by a single-precision vector (second argument). The single-precision result is returned as the third argument.

54. NAD

Subroutine NAD converts a set of instantaneous orbit elements to an inertial state vector.

Additional documentation is provided in Ref. 2.

55. NIPS

Subroutine NIPS interprets an arroy of field data words read from the input control cards and stores the information into blank common.

NIPS sets up a code (ITABLE) for each of the field data codes it recognizes out of all of the 1108 field data codes. Each six-bit portion of each word in the array is then interpreted with each nonpermissible character treated as a blank. A character string is built up of the interpreted characters, which is terminated when a blank is reached. The string is built into a meaningful computer word (or words) as it is being interpreted.

Variable N keeps track of the operation, i.e., whether a floating point number, octal number, E-format number, etc., is being interpreted. Variable K keeps track of which one of the acceptable characters is being operated on.

The calling sequence of subroutine NIPS is:

Call NIPS (A, NK, X, I)

where

A = array of field data characters to be interpreted

NK = on entry, the number of field data characters to be interpreted; on return, number of interpreted words stored

X = array to be loaded with interpreted words

I = first word of X which is to be loaded with first word interpreted from A

56. NOISE

Subroutine NOISE generates the discrete colored-noise that is added to azimuth, and elevation data in all portions of the simulation. The integer argument of the entry point, NOISE, may have a value from 1 through 6. When the argument is 1 or 5, the noise constants and the noise generators are initialized for slow data taking. When the argument is 2, the noise generators are auto-correlated over the fixed time interval dictated by the data acquisition process. When the argument is 3 or 4, the generators are auto-correlated in accordance with a fixed time interval or the time interval between data groups. When the argument is 6, the noise is not colored.

Additional documentation is provided in Ref. 4.

57. ORBITA

Subroutine ORBITA computes in double precision the orbital elements of the Tug and/or payload orbit, given the position and velocity vectors in earth-centered inertial coordinates. The integer argument of the entry point, ORBITA, may have

the values, 1 through 3. If 1, orbital elements are computed for the interceptor; if 2, the elements are computed for the target; and if 3, orbital elements for both are computed.

Additional documentation is provided in Ref. 4.

58. OUTPT3

Subroutine OUTPT3 performs its output function for most of the output data generated during the execution of LOCKOK.

59. OVERLP

Subroutine OVERLP searches the data input tape to set up table of first-and last-time values in each of the data files for plotting.

Additional documentation is provided in Ref. 5.

60. PATCH

Subroutine PATCH enables the operator to input initial values for nearest approach conditions, runs them back to acquisition range, and supplies these starting points to EXEC4 for proportional guidance. PATCH is not used in the docking coding.

61. PCOMP

Subroutine PCOMP computes six orbital constants required for the iterative solution of Kepler's equation for either the Tug or payload. If the integer argument is 1, the Tug orbital constants are computed; and if 2, the payload orbital constants are computed. This subroutine is called by ORBITA.

62. PLOTOP

Subroutine PLOTOP is the executive routine of the LOCDOK Plot Package, which reads and plots data from the LOCKOK data tape. The subroutine has the capability of performing mathematical manipulations on the plot variables. The

manipulated variable may be either on the **abscissa** (V_x) or the ordinate (V_y). The second variable may be an input constant. Listed below are four examples of the specified manipulations.

$$V_x = V_{x1} + V_{x2} \quad \text{or} \quad V_y = V_{y1} + V_{y2}$$

$$V_x = V_{x1} - V_{x2} \quad \text{or} \quad V_y = V_{y1} - V_{y2}$$

$$V_x = V_{x1} * V_{x2} \quad \text{or} \quad V_y = V_{y1} * V_{y2}$$

$$V_x = V_{x1} / V_{x2} \quad \text{or} \quad V_y = V_{y1} / V_{y2}$$

The capability to search the data tape for the proper variables is coded. The Plot Package will operate without the excution of any other program segment of LOCKOK. All graphs are fully annotated and the capability for handling a segmented program is incorporated.

The data to be plotted must be contained on one or more seven-track magnetic tapes. (See Para. 2.5.1.2 for format description.) Successive reels of input tape must be assigned to successive logical units. For example, Tape 1 is assigned to logical Unit 25, Tape 2 to logical Unit 26, etc.

This subroutine is the main driver of the LOCKOK Plot Package. Additional information on the Plot Package is provided in Ref. 5 and 10.

63. PLTPG

Subroutine PLTPG generates a 32 cell data array required by subroutine WRIDAT as input. This array contains time and any of the 32 other data quantities specified in the LOCKOK dictionary that are calculated. If a data quantity is not calculated it is set to 1.0E-35.

64. RANDM

This subroutine is the random number generator used by LOCDOK.

65. READT

Subroutine READT in the 1108 version uses NTRAN to read the input data tape.

This subroutine is part of the LOCDOK Plot Package. Additional documentation is provided in Ref. 5.

66. RELKIN

Subroutine RELKIN computes the relative kinematic and tracking function variables.

Additional documentation is provided in Ref. 4.

67. RELK2

Relative knematic and tracking function variables are computed in this subroutine.

This subroutine is a shortened version of RELKIN.

68. RETRO2

Subroutine RETRO2 computes the propellant required to abort and re-dock from the test point, R_D. The equations coded are developed in Ref. 11.

69. ROTMT

Subroutine ROTMT computes the rotational transformation matrix from the four component Euler parameter vector as required by the detailed attitude control simulation. This matrix is the transformation from inertial to vehicle body frames.

Additional documentation is provided in Ref. 4.

70. RVTOC

Subroutine RVTOC computes the Tug position and velocity vectors in the payload orbital coordinate system and the payload position and velocity vectors in the tug orbital coordinate system.

71. RVTOC2

Subroutine RVTOC2 computes the Tug position and velocity vectors in the payload orbital coordinate system and the position and velocity vectors in the interceptor orbital coordinate system.

72. SCLGRD

Subroutine SCLGRD writes out the plot title, the plot grid, and the plot scaling onto SC-4020 plot output tape.

This subroutine is part of the LOCDOK Plot Package. Additional information is provided in Ref. 5.

73. SETUPP

Subroutine SETUPP sets up the required switching constants that indicate the number of parameters to be plotted, the desired mathematical manipulations to be performed, and the desired scale factors to be used.

Additional information is available in Ref. 5.

74. SUPER

Subroutine SUPER performs data-taking-and-fitting or adds a burn to the trajectory of the tug. With CONDEV(I)=0.0, subroutine SUPER adjusts the data taking rate to match the input integration step size and calls for either linear data fitting (smoothing by accumulation) or Kalman filtering. With CONDEV(I) = 0.0 subroutine adjusts burn durations to be compatible with the input intregration step size. In either CONDEV mode, the equations of motion are integrated numerically by calling CMAND. Outputs from SUPER include smoothed sensor data and new state vectors (burns added).

75. TAN2PI

Subroutine TAN2PI finds the tangent of X/Y where X and Y are inputs. The angle that is output is between 0 and 2π.

76. TERMEX

Subroutine TERMEX is the driver for the terminal maneuvers section of LOCOK.

77. TESTER

Subroutine TESTER receives the current and desired values of position, velocity, and attitude of the tug relative to the payload, along with input values of the docking tolerances. It compares differences of position, velocity, and attitude with the tolerances at the abort range, judges the accuracy, and writes appropriate comments.

78. TIGHT

Subroutine TIGHT performs the following update function: In the fast-transfer-to-a-point maneuver logic, a 3 by 3 matrix is generated that relates conventional in-track, radial, cross-track position differences to a system with one axis aligned with a straight line drawn between a selected final position and the current position. Two orthogonal axes are perpendicular to this first axis. It is desirable to update this 3 by 3 matrix during the guidance interations because the selected final position is shifted.

79. WHIZ

Subroutine WHIZ is a general-purpose subroutine which advances a given state vector forward or backward for a given amount of time to generate a second state vector. The coding is based on the "RIGHT1" general-purpose program of Ref. 2.

80. WRIDAT

Subroutine WRIDAT is the driver for the package which generates the data output tape. This tape contains the time-history information to be plotted. WRIDAT, along with subroutine WRIT25 which is calls, is allocated the resident segment in core so that it may be called by any of the overlayed segments wishing to access it.

Additional documentation is provided in Ref. 5.

81. WRIT25

Subroutine WRIT25, driven by WRIDAT, outputs the LOCKOK program data values to seven-track magnetic tape.

Section 2

USAGE INFORMATION

2.1 EQUIPMENT CONFIGURATION

The minimum capability and equipment required to execute LOCDOK are:

- o 177,777 octal words of core
- o Line printer, if direct print out is required
- o Tape units:
  - – Data tape to generate a plot tape – this tape is generated by option
  - – Plot tape for SC-4020 plotter – this tape is generated only if 4020 plots are required

2.2 REQUIRED SOFTWARE

Narratives for all subroutine elements and functions of LOCDOK are shown in Section 1.4. The Univac 1108 system and library functions are listed in Table 1-2.

2.3 STORAGE REQUIREMENTS

2.3.1 Primary (Core) Storage

Required core storage capacity for execution is 62,782 decimal words.

2.3.2 Secondary (Auxiliary) Storage

The secondary storage required is in the form of the data tapes which are used to store information required by the plot package to generate the SC-4020 plot tape, and this plot tape itself. This latter tape is used by the 4020 plotter to generate hardcopy.

2.4 PROGRAM OPTIONS

The basic options or main program sections which may be called out by LOCKOK are as follows:

- o Docking Maneuver
- o Plot

Inputs A4, A5, and A6 (see LOCDOK Input Dictionary, Appendix A) are the controls for the LOCDOK program options. Other program options are defined in the LOCDOK Input Dictionary.

If input A6 is greater than zero, the plot option is requested. If A6 is less than zero, the case being generated is the last case on the data tape. This data tape is generated if input A5 is a valid number.

2.5 DATA AND CONTROL CHARACTERISTICS

2.5.1 Input

The LOCDOK program has a set of preset data which may be changed by input cards (see LOCDOK Input Dictionary - Appendix A - for preset values.) In addition, to card-input the plot package requires a magnetic tape containing a time history of the data to be plotted.

2.5.1.1 Input Control and Data Cards

The LOCDOK Input Dictionary (Appendix A) describes all options that are to be free-field formatted for input. On each input card, there are four fields as shown below:

Field	Card Columns	Type Field	Purpose of Field
1	1	Fixed	Input block identifier
2	2-5	Free	Relative location in the specified input block

2.5.1.1 (Continued):

Field	Card Columns	Type Field	Purpose of Field
3	6-8	Fixed	Special designators
4	9-80	Free	Input data

The input data block identifier (a letter from A to Z) is entered into field 1, and corresponds to the input data block in which the information in field 4 is to be enetered. Field 2 gives the relative position within the input data blocks, specified by field 1, in which the first entry in field 4 is to be stored. Field 3 is for special control input. Entries to it are as follows:

- END - tells the program that all the data for the case have been input, and to proceed with the processing.
- FIN - tells the program that there will be no more processing, and a call to EXIT is processed.
- ENP - processes a call to EOFTV, and then continues reading data until either an END or a FIN card is read.

Field 4 is the free field in which the data are to be specified. Since the input blocks are initialized to the preset value listed in the Dictionary, only the data which the user desires to change must be read in. The type of input (integer, real, alphameric) is indicated by the type of the preset value given.

Field 1 may be left blank; if so, the relative address (field 2 is assumed to reference the input block named in the previous card. If field 2 is also left blank, the first entry in field 4 is assumed to be referenced to the relative address immediately following the relative address of the last entry on the previous card. Each entry into input initializes field 1 to Code A.

Within the data field (field 4), several different types of entries may be made. Since not all of the data will be numbers, and since the free-field format input references specific computer words in core storage, other

"input directives" are available to facilitate the loading of the input data. A list of "input directives" available to the user follows:

Directive	Usage
B	Denotes that the immediately following number (no blanks) is an octal entry. The number usually will be 12 digits in length for the Univac 1108.
E	Denotes that the immediately preceding number (no blanks) is to be multiplied by ten (10.0) to the power immediately following (no blanks) the E (i.e., E format).
H	Denotes that the immediately following alphameric character string of the length given by the immediately preceding integer number (no blanks) is to be loaded as a hollerith field would be.
R	Directs the repeated loading of the most recently loaded entry in field 4. The integer number immediately following (no blanks) this directive designates the number of words to be consecutively loaded with the same entry as the most recently loaded value.
S	Directs the loading routine to skip over the next k words in the loading process, where k is the integer number immediately following (no blanks) this directive.
W	Same as H directive except that the immediately preceding integer number (no blanks) denotes the number of words (6 characters each for the Univac 1108) to be loaded.
( )	Denotes that the information enclosed within the parentheses is not to be considered as data to be loaded, but only a comment.

Examples of an input control card illustrating the above directives are shown in Fig. 2-1. The result of these three cards are shown in Table 2-1 for the I block.

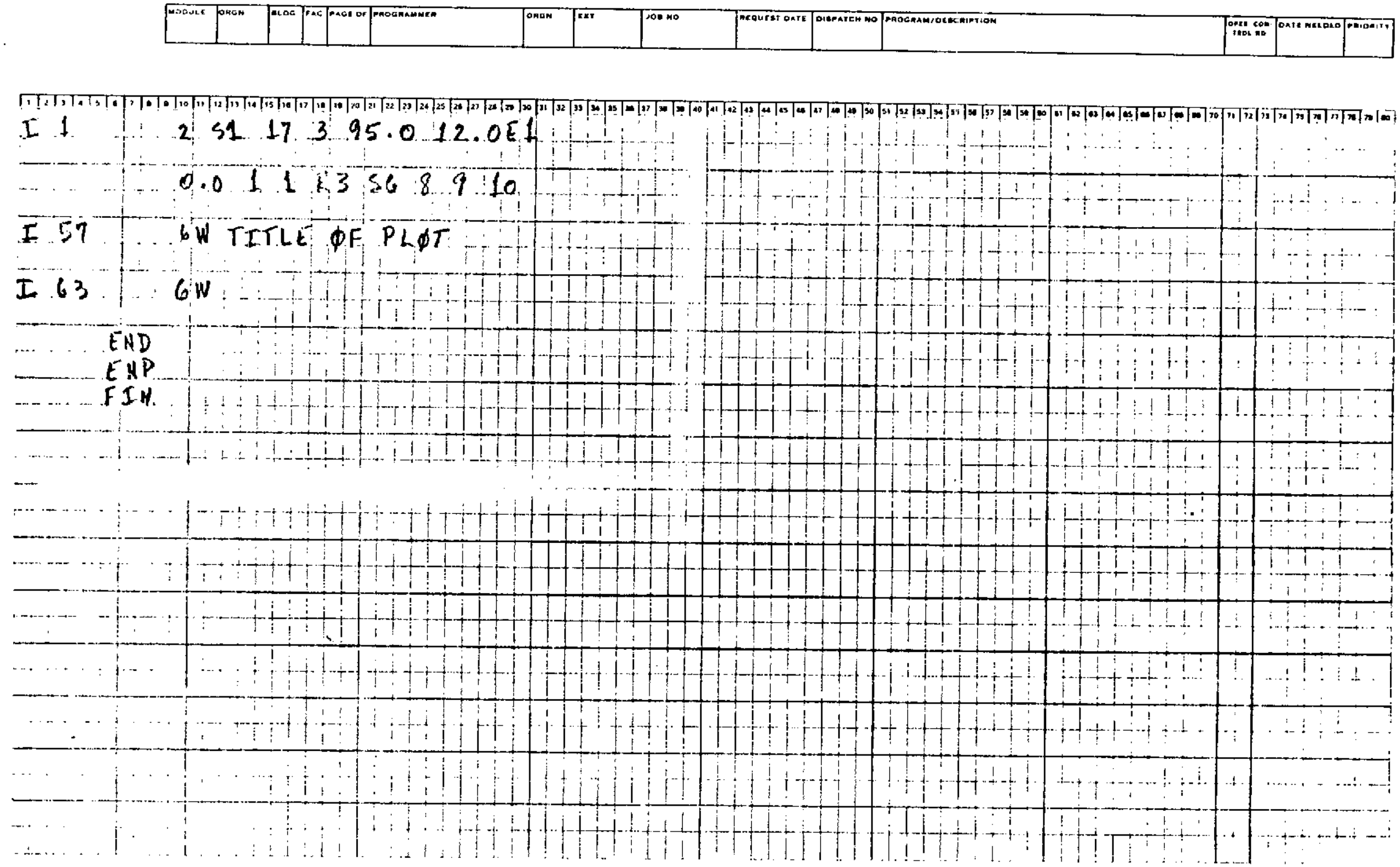

Fig. 2-1 Data Input Card Format

Table 2-1

I BLOCK CHANGES FROM DICTIONARY DUE TO INPUT

OF DATA INPUT CARD FORMAT[a]

Relative Address		Before Input	After Input
I	1	1	1
I	2	9	9
I	3	25	17
I	4	1	3
I	5	0.0	95.
I	6	100.	120.
I	7	0.0	0.0
I	8-12	1	1
I	19	1	1
I	20	2	8
I	21	0	9
I	22	0	10
I	57		${}_b$TITLE[b]
I	58		${}_b$OF${}_b$PL
I	59		OT$_{bbbb}$
I	60-68		(all blanks)

(a) See Fig. 2-1

(b) Subscript b denotes a blank or space

2.5.1.2 Magnetic Tape Formats

The program inputs to the plot package via one or more magnetic tapes generated by the WRIDAT and WRIT25 subroutines. The tape consists of n data files, each file having one code record in the beginning and m data records. The code record has 10 data words of which only the first five are used to store information. The first three words are integers while the next two are real numbers. Word 1 is a number which represents the section of program which generated the data file; word 2 is the case number presently being processed; word 3 is the number of the file; word 4 is time; and word 5 is a very large number that must be greater than the maximum time of the case (presently set by program to 1.0520). Each subsequent record of the file contains 10 sets of the 35 different data quantities outputted by the program (see LOCDOK Input Dictionary, Appendix A). The last file on the tape has two end-of-files following it.

Each tape contains any number of files. Each file contains flags and data for one type of output, and any number of records.

The first physical record of each file will consist of ten words:

	Word	Contents
	1	Type of data flag (integer)
ID record (record 1)	2	Case number (integer)
	3	File number
	4	Time of first sample of this file
	6-10	Currently unused

All physical records in a file after the ID record contain a maximum of 350 words, or ten data sets (time and 31 dependent parameters).* The last data record in a file may contain fewer than ten data sets.

Each file is ended by an end-of-file mark. If the tape is written on more than one reel, an end-of-file is written, and a five-word flag record immediately follows the end-of-tape mark. The format of the flag record

---

* The descriptions of the 32 parameters are given in Table 2-2.

is as follows:

FLAG record	1	REEL
	2	Integer reel number (1, 2, ...)
	3	Number files reel
	4-5	Zero

Table 2-2

INPUT PARAMETERS LOCATIONS AND DESCRIPTIONS

Location	Description
1	Time (sec)
2	Slant Range (ft) (M)
3	Range R te (ft/sec) (M/sec)
4	Elevation (deg) (rad)
5	Azimuth (deg) (rad)
6	LOS Rate Elevation (deg/sec) (rad/sec)
7	LOS Rate Azimuth (deg/sec) (rad/sec)
8	IT Range (ft) (M)
9	CT Range (ft) (M)
10	RAD Range (ft) (M)
11	IT Velocity (ft/sec) (M/sec)
12	CT Velocity (ft/sec) (M/sec)
13	RAD Velocity (ft/sec) (M/sec)
14	Total Impulse, Remaining Main Tank
16	Total Impulse, Remaining, APSTANK
17	Total Impulse, Attitude Control Subsystem
18	Vehicle Pitch Attitude (deg) (rad)
19	Vehicle Yaw Attitude (deg) (rad)
20	Vehicle Roll Attitude (deg) (rad)
21	Vehicle Pitch Rate (deg/sec) (rad/sec)
22	Vehicle Yaw Rate (deg/sec) (rad/sec)
23	Vehicle Roll Rate (deg/sec) (rad/sec)
24	X, in Earth-Centered Coordinate System (ft) (M)
25	Y, in Earth-Centered Coordinate System (ft) (M)
26	Z, in Earth-Centered Coordinate System (ft) (M)
27	X-rate Earth-Centered Coordinate System (ft/sec)(M/sec)
28	Y-rate Earth-Centered Coordinate System (ft/sec) (M/sec)
29	Z-rate Earth-Centered Coordinate System (ft/sec) (M/sec)
30	Altitude (nm) (km)
31	APS Translational Thrust No.
32	Slant Range (nm) (KM)
33	Inertial Velocity (ft/sec) (M/sec)

2.5.1.3 Input Restrictions

All available input, other than the input data tape required by the plotting section, is described in the LOCDOK Input Dictionary.

2.5.1.4 Sample Input

Fig. 2-2 depicts a set of sample inputs. This set sends the LOCDOK program to the plotting section. The first card which modifies the data in the sixth word of the A block is the plotting control of the LOCDOK program. An integer 1 indicates that plots are to be generated from a data tape. The next four cards shown on Fig. 2-2 modify the data in the I block. The END card tells the program to process the case. The ENP card processes a clean up of the plotting routine. This clean up is performed after the last plot is processed. The FIN card indicates to the program that no more cases are to be run.

```
A   6      1                                     — GENERATE PLØTS FRØM DATA TAPE

I   1      2  S1 17  3  95.0  12.0E1
           0.0  1 1  R3  S6  1  8 9 10

I  57      6W TITLE ØF PLØT
I  63      6W
     END
     ENP
     FIN
```

Fig. 2-2 Sample Input Data

2.6 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

2.6.1 Deck Card Setup

Refer to user's manual for computer operating system installed.

2.6.2 Magnetic Tape Setup

LOCDOK may have three types of magnetic tapes:

- Program tape - input tape, output tape, if new tape is generated
- One or more data tapes - these tapes may be either input or output
- SC-4020 plot tape - output tape

The logical assignment, as well as the densities of all tapes, are specified by the user.

2.6.3 Run Preparation Procedure

For the Univac 1108, the card deck sets up the run. No special requests are required.

2.6.4 Program Messages and Recovery Procedures

The LOCDOK program is a simulation program which does not have a recovery procedure. If the program is given an unrealistic case, it will either run until completion or until a nonrecoverable error is processed, e.g., taking the square root of a negative number. At the time the nonrecoverable error is processed, a program dump may be processed by the 1108 operating system.

Section 3

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Appendix A

LOCDOK INPUT DICTIONARY

LOCDOK

INPUT DICTIONARY

(SI UNITS)

```
                        LOCDOK INPUT DICTIONARY        PAGE  1
                              23 JUNE 1974              OF   13

RELATIVE   PRESET    FORTRAN            PURPOSE
ADDRESS    VALUE     NAME

                                 *** MAIN PROGRAM CONTROLS

        *** THE FIRST INPUT CARD MUST ALWAYS BE AS FOLLOWS:
             A BLANK CARD IF THE UNITS ARE ENGLISH
             A 1 PUNCHED IN COLUMN 3 IF THE UNITS ARE SI

                                 *** DATA CARDS
A  1       1           ICASE     CASE NUMBER
A  5       1          IOUTJW     UNIT OF THE DATA TAPE. IF IOUTJW IS LESS
                                 THAN 15, NO DATA TAPE IS GENERATED. THIS DATA
                                 TAPE CONTAINS THE SETS OF TIME DEPENDENT DATA,
                                 FROM WHICH THE PLOTS ARE GENERATED.
A  6       0              IP     PLOT AND DATA TAPE CONTROL
                                 IP=1 GENERATE PLOTS FROM A DATA TAPE
                                 IP=0 MAKE A PLOT DATA TAPE IF IOUTJW IS
                                      GREATER THAN 14.
                                 IF MORE THAN ONE DATA TAPE IS NEEDED,A 5
                                 DOES NOT HAVE TO BE CHANGED, BUT THE EXTRA
                                 TAPE UNITS MUST BE ASSIGNED WITH UNIT # =
                                 IOUTJW+1.
                                 IP=-1 SAME AS IP=0,AND TELLS PROGRAM THAT THIS
                                        IS THE LAST CASE TO BE WRITTEN ON DATA TAPE
A  7-18                TITLE     CASE TITLE CARD
```

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** PROGRAM CONTROLS
F 97	0	METRIC	1 IS METRIC, 0 IS ENGLISH
G 3	4	MANUVR	TERMINAL RENDEZVOUS MANEUVER CONTROL IS A LEFT REGISTERED FIVE DIGIT NUMBER. EACH DIGIT IS PROCESSED SEQUENTIALLY. ALL DIGITS NOT SPECIFIED BELOW ARE SKIPPED. DIGIT=4 DOCKING
H 2	400	IPPT4	OUTPUTS DATA EVERY NTH.INTEGRATION STEP
			**TIMING PARAMETERS
G 11	0.0	STIME	PROBLEM STARTING TIME, SECONDS
G 12	17000.	STIMAX	MAXIMUM SYSTEM TIME FOR RUN (SEC) ONLY FOR 1ST TRACKING INTERVAL
G 19	0.3	HFD	TIME BETWEEN DATA POINTS TO COMPUTER (SEC)
G 22	10.	TMIN	MINIMUM TIME ALLOWED FOR TRANSFERS, SEC
G 23	13500.	TMAX1	MAXIMUM ALLOWED TRANSFER TIME, SEC
G 37	120.	DLTORI	TIME ALLOWED FOR ROTATION OF TUG PRIOR TO START OF DOCKING, SEC.
H 1	.01	HPG	INTEGRATION STEP SIZE FOR DETAILED ATTITUDE CONTROL AND BURNS IF HPG = 0.0, THEN HPG IS SET TO HFD
H 89	20.	TDELI	TIME DELAY BEFORE THE START OF P.G., SEC
H 90	0.0	TSWTCH	TIME AT WHICH SECOND SET OF LOS RATE SWITCHING LINES ARE IMPLEMENTED IF TSWTCH IS GREATER THAN ZERO (0), SEC

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** TUG/PAYLOAD INITIAL POSITION AND VELOCITY
G 39	42097811.6	RV(1,1)	INERTIAL COORDINATE OF THE TUG (X), M
G 40	-55559.9	RV(2,1)	INERTIAL COORDINATE OF THE TUG (Y), M
G 41	59325.1	RV(3,1)	INERTIAL COORDINATE OF THE TUG (Z), M
G 42	42157077..	RV(1,2)	INERTIAL COORDINATE OF THE PAYLOAD (X), M
G 43	0.0	RV(2,2)	INERTIAL COORDINATE OF THE PAYLOAD (Y), M
G 44	60.96	RV(3,2)	INERTIAL COORDINATE OF THE PAYLOAD (Z), M
			*VELOCITY IN M/SEC
G 45	8.31918	VV(1,1)	INERTIAL VELOCITY OF THE TUG (XDOT)
G 46	3073.853	VV(2,1)	INERTIAL VELOCITY OF THE TUG (YDOT)
G 47	-4.2672	VV(3,1)	INERTIAL VELOCITY OF THE TUG (ZDOT)
G 48	0.0	VV(1,2)	INERTIAL VELOCITY OF THE PAYLOAD (XDOT)
G 49	3074.518	VV(2,2)	INERTIAL VELOCITY OF THE PAYLOAD (YDOT)
G 50	0.0	VV(3,2)	INERTIAL VELOCITY OF THE PAYLOAD (ZDOT)

IF THE TUG STATE IS DESIRED TO BE INPUT RELATIVE TO THE PAYLOAD THEN G 39, G 40, AND G 41 BECOME DELTA CROSS TRACK, DELTA RADIAL, AND DELTA IN TRACK. G 45, G 46, G 48 BECOMES DELTA CT DOT, DELTA R DOT, AND DELTA IT DOT.
RELATIVE POSITIONS ARE ASSUMED IF THE RMS OF THE THREE RANGE INPUTS IS LESS THAN THE EQUITORIAL RADIUS.
THE DELTAS ARE ADDED TO THE PAYLOAD ORBIT TO OBTAIN THE TUG ORBIT.

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			**MASS PROPERTIES
G 19	309.8139	AUXFUL	APS PROPELLANT MASS (KG)
G 51	2341.369	FMBS	TUG DRY MASS (KG)
G 52	1205.763	FMFS	TUG MAIN ENG PROPELLANT MASS (KG)
			**PROPULSION
G 13	11.121	FJSUBT	MIN IMPULSE BIT LATERAL ENG. (N-SEC)
G 16	2.224	TOIU	TAIL OFF UNCERTAINTY OF LAT. ENG. (N-SEC)
G 53	14234.3	DELJM	TAIL-OFF IMPULSE OF MAIN ENGINE. (N-SEC)
G 54	22.2411	DELJS	TAIL-OFF IMPULSE OF THE AXIAL SECONDARY ENGINES (N-SEC)
G 55	6672.23	FJSUBM	MINIMUM IMPULSE OF MAIN ENGINE. N-SEC
G 56	11.1206	FJSUBS	MINIMUM IMPULSE OF THE AXIAL SECONDARY ENGINES (N-SEC)
G 57	230.0	FIST	SPECIFIC IMPULSE OF THE LATERAL ENGINES (SEC)
G 58	444.0	FIMS	SPECIFIC IMPULSE OF MAIN ENGINE (SIM) SEC
G 59	230.0	FISS	SPECIFIC IMPULSE OF THE AXIAL SECONDARY ENGINES (SEC)
G 60	0.	FKVB	PERCENT ERROR IN BURN MAGNITUDES
G 61	66722.3	TMS	MAIN ENGINE THRUST LEVEL, N
G 62	444.822	TSS	THRUST LEVEL OF THE AXIAL SECONDARY ENGINES (N), LOS ENG
G 63	444.822	TST	THRUST LEVEL OF THE LATERAL ENGINES (N)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** NOISE AND ERROR PARAMETERS
G 2	1	KONTAM	KONTAM INITIALIZES NOISE GENERATOR.0 DOESNT
			*** FOR ZERO NOISE SET STD(I) TO 0.0
			(1),(2)=RANGE (M)
			(3),(4)=RANGE RATE (M /SEC)
			(5),(6)=ELEVATION RATE LOS (RAD/SEC)
			(7),(8)=AZIMUTH RATE LOS (RAD/SEC)
H 4-11	314.159	BANDW(I)	BANDWIDTH OF THE 8 COLORED NOISE GENERATORS IN RAD/SEC
H 12-19	1.0	CSTAR(I)	COEFFICIENTS OF THE NOISE TERMS
			EXPONENTS OF THE NOISE TERMS
H 20	1.0	EXPON(1)	
H 21	0.0	EXPON(2)	
H 22	1.0	EXPON(3)	
H 23	0.0	EXPON(4)	
H 24	1.0	EXPON(5)	
H 25	-1.	EXPON(6)	
H 26	1.0	EXPON(7)	
H 27	-1.	EXPON(8)	
H 28-35	.3048	RLWR(I)	LOWER BREAK POINT FOR 8 RANGE DEPENDENT NOISE PARAMETERS, (M)
H 36-43	143715.2	RUPR(I)	UPPER BREAK POINT FOR RANGE 8 DEPENDENT NOISE PARAMETERS, (M)
			STANDARD DEVIATIONS OF THE 8 NOISE GENERATORS
H 44	7.265	STD(1)	
H 45	0.0	STD(2)	
H 46	0.0	STD(3)	
H 47	0.0	STD(4)	
H 48	0.0	STD(5)	
H 49	0.0	STD(6)	
H 50	0.0	STD(7)	
H 51	0.0	STD(8)	

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			TO SET NOISE TO ZERO, JUST SET SIGSR(I) TO 0.0
		(3),(4)	AZIMUTH (RAD)
		(5),(6)	ELEVATION (RAD)
			COEFFICIENTS OF NOISE TERMS
G 73	1.	BSTAR(3)	
G 74	1.	BSTAR(4)	
G 75	1.	BSTAR(5)	
G 76	1.	BSTAR(6)	
			EXPONENT OF NOISE TERMS
G 79	1.	P(3)	
G 80	-1.	P(4)	
G 81	1.	P(5)	
G 82	-1.	P(6)	
			UPPER BREAK-POINTS FOR RANGE DEPENDENT NOISE, M
G 85-88	143715.2	RU(I)	I = 3 TO 6
			LOWER BREAK-POINTS FOR RANGE DEPENDENT NOISE, M
G 91-94	.3048	RL(I)	I = 3 TO 6
			STANDARD DEVIATIONS OF THE NOISE GENERATORS.
G 97	2.90855E-4	SIGSR(3)	
G 98	1.30878E-7	SIGSR(4)	
G 99	2.90855E-4	SIGSR(5)	
G 100	1.30878E-7	SIGSR(6)	
			• BANDWIDTHS OF THE 4 COLORED-NOISE GENERATORS (RADIANS/SECOND)
G 106-109	314.1594	OMEGSR(I)	FOR I= 3-6
			••SINUSOIDAL NOISE
G 146	0.	GG1(1)	EL RATE FREQ. (HERTZ)
G 147	0.	GG1(2)	AZ RATE FREQ. (HERTZ)
G 148	0.	GG1(3)	EL RATE MAX AMPLITUDE (RAD/SEC)
G 149	0.	GG1(4)	AZ RATE MAX AMPLITUDE (RAD/SEC)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** SENSOR PARAMETERS
F 44	16.	RRR	BASIC SENSOR MEASUREMENT REPETITION RATE, MEASUREMENTS PER SECOND
F 98	143.7152	SACCOL	ACQ. RANGE OF DOCKING SENSOR (KM)
G 15	0.5236	RITASP	1/2 ACCEPTANCE ANGLE OF DOCKING AID (RAD)
			** RESOLUTION AND BIAS ERRORS OF SENSOR
D 29	0.	SIGMA(1)	RESOLUTION IN RANGE RATE,M /SEC
D 30	0.	SIGMA(2)	RESOLUTION IN AZIMUTH RATE, RAD/SEC
D 31	0.	SIGMA(3)	RESOLUTION IN ELEVATION RATE, RAD/SEC
D 33	.09144	SIGMB(1)	RANGE RESOLUTION IN METERS
D 34	4.363E-4	SIGMB(2)	AZIMUTH RESOLUTION IN RAD
D 35	4.363E-4	SIGMB(3)	ELEVATION RESOLUTION IN RAD
H 52	0.0	DELSB	RANGE BIAS, (M)
H 53	0.0	DLSDB	RANGE RATE BIAS, (M /SEC)
G 113	0.	DELAZB	AZIMUTH BIAS ERROR, RAD
G 114	0.	DELELB	ELEVATION BIAS ERROR, RAD
H 54	0.0	DLOMZB	ELEVATION RATE BIAS, (RAD/SEC)
H 55	0.0	DLOMYB	AZIMUTH RATE BIAS, (RAD/SEC)
H 93	0	ISEN	TYPE OF SENSOR USED 0=GIMBALLED 1=BODY FIXED

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			***GUIDANCE PARAMETERS
G 17	3.	DAMP	EXPONENT FOR DOCKING AXIS GUIDANCE
H 77	1.E+10	FK(1)	THE PROPORTIONALITY CONSTANT THAT SWITCHES THE AXIAL ENGINES ON
H 78	0.0	FK(2)	THE PROPORTIONALITY CONSTANT THAT SWITCHES THE AXIAL ENGINES OFF
H 79	1.22E+5	RSUBB(1)	STANDOFF RANGE FOR MAIN ENGINE, M
H 80	4.1758	RSUBB(2)	STANDOFF RANGE FOR APS ENGINE, M
H 81	3.E-5	OMHI	THE LOS RATE ABOVE WHICH A LATERAL THRUST IS ON (RAD/SEC)
H 82	1.E-5	OMLO	THE LOS RATE BELOW WHICH A LATERAL THRUST IS OFF (RAD/SEC)
H 83	4.0	PROCON	THE NAVIGATION CONSTANT
H 84	4.1758	RSUBF	THE RANGE AT WHICH P.G. IS TERMINATED, M
H 85	0.003048	RSUBFD	THE RANGE RATE AT WHICH P.G.IS TERMINATED (M/SEC)
H 91	1.E-3	OMLO2	ALTERNATE VALUE OF OMLO AT TSWTCH, RAD/SEC
H 92	3.E-3	OMHI2	ALTERNATE VALUE OF OMHI AT TSWTCH, RAD/SEC
			*** DATA FILTERING
G 6	100	NSUBF	NUMBER OF DATA POINTS TO BE USED IN DATA FITTING.
G 14	1	KSWICH	0 IS LINEAR DATA FILTER, 1 IS KALMAN
H 86	0.0	TAUDA(1)	TIME CONSTANT OF GUID LOW-PASS FILTER, RANGE (SEC)
H 87	0.0	TAUDA(2)	TIME CONSTANT OF GUID LOW-PASS FILTER RANGE RATE (SEC)
H 88	0.0	TAUDA(3)	TIME CONSTANT OF GUID LOW-PASS FILTER, LOS RATE (SEC)
H 100	0	IFILT	TYPE OF GUIDANCE FILTER 0=SINGLE ORDER LOW PASS 1=6 POLE BUTTERWORTH
			*** ABORT PARAMETERS
D 55	3600.	TI	TIME ELAPSED TO START DOCKING APPROACH AFTER ABORT (SEC)
D 56	33.34	PW	WIDTH OF PAYLOAD (M)
D 57	20.	YSAFTY	CLEARANCE BELOW PAYLOAD REQUIRED FOR AN ABORT (M)
D 58	16.67	YC	PAYLOAD LENGTH BELOW DOCKING AXIS (M)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			***DOCKING PARAMETERS
			*** ACCURACY REQUIREMENTS AT ABORT RANGE ***
F 88	.1524	TOLPOS(1)	POSITION ALONG DOCKING AXIS (M)
F 89	.2159	TOLPOS(2)	POSITION NORMAL TO DOCKING AXIS (M)
F 90	.2159	TOLPOS(3)	POSITION NORMAL TO DOCKING AXIS (M)
F 91	.00396	TOLVEL(1)	VELOCITY ALONG DOCKING AXIS (M/SEC)
F 92	.00396	TOLVEL(2)	VELOCITY NORMAL TO DOCKING AXIS (M/SEC)
F 93	.00396	TOLVEL(3)	VELOCITY NORMAL TO DOCKING AXIS (M/SEC)
F 94	.05236	TOLANG(1)	ROLL ANGLE (RAD)
F 95	.05236	TOLANG(2)	YAW ANGLE (RAD)
F 96	.05236	TOLANG(3)	PITCH ANGLE (RAD)
G 116	.061	DMIN	MINIMUM TRANSFER LENGTH BELOW WHICH A NEW TRANSFER IS NOT STARTED (M)
			DISPLACEMENT OF DOCKING SENSOR BORE-SIGHT TO DOCKING MECHANISM CENTER-LINE
G 117	0.	G(117)	DESIRED FINAL IN-TRACK POSITION, M
G 118	0.	G(118)	DESIRED FINAL RADIAL POSITION, M
G 119	0.	G(119)	DESIRED FINAL CROSS-TRACK POSITION, M
G 123	6.1	RSUBMT	MISS DISTANCE THRESHOLD IN GROSS-TRANSFERS, (M)
G 124	-1.	UNR2(1)	DIRECTION COSINE OF DESIRED DOCKING AXIS (IT)
G 125	0.	UNR2(2)	DIRECTION COSINE OF DESIRED DOCKING AXIS (RAD)
G 126	0.	UNR2(3)	DIRECTION COSINE OF DESIRED DOCKING AXIS (CT)
G 127	4.17576	RSUBD	RANGE IN DOCKING MANEUVERS WHERE CLOSING VELOCITY SWITCHES TO DOCKING VELOCITY (M) THIS IS ALSO THE ABORT RANGE
G 130	304.8	R2MIN	MINIMUM DISTANCE ON THE DOCKING AXIS WHERE A FINAL DOCKING APPROACH COULD BE STARTED, M
G 131	1.524	VOD	VEL PARALLEL TO THE DOCKING AXIS (M/SEC)
G 132	0.1524	VDOCK	MAGNITUDE OF DESIRED FINAL IMPACT VELOCITY IN DOCKING MANEUVERS, M/SEC.

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			***ATTITUDE CONTROL PARAMETERS (1)=ROLL, (2)=YAW, (3)=PITCH
G 151	1		ATTITUDE CONTROL SYSTEM SELECTION 0=DETAILED, 1=PERFECT
			MIN ANG IMPULSE BIT REACTION CONTROL SYS
G 157	22.8794	SEN(6)	ROLL (M-N-SEC)
G 158	10.0274	SEN(7)	YAW (M-N-SEC)
G 159	10.0274	SEN(8)	PITCH (M-N-SEC)
H 56	7157.37	INERT(1)	PRINCIPLE MOMENTS OF INERTIA OF THE TUG (M-N-SEC2)
H 57	58594.47	INERT(2)	PRINCIPLE MOMENTS OF INERTIA OF THE TUG (M-N-SEC2)
H 58	58907.67	INERT(3)	PRINCIPLE MOMENTS OF INERTIA OF THE TUG (M-N-SEC2)
H 59	7.862	FKGA(1)	ATTITUDE POSITION GAIN CONSTANT
H 60	146.837	FKGA(2)	ATTITUDE POSITION GAIN CONSTANT
H 61	147.624	FKGA(3)	ATTITUDE POSITION GAIN CONSTANT
H 62	157.24	FKGD(1)	ATTITUDE RATE GAIN CONSTANT
H 63	2936.74	FKGD(2)	ATTITUDE RATE GAIN CONSTANT
H 64	2952.49	FKGD(3)	ATTITUDE RATE GAIN CONSTANT
H 65	0.0	TAUT(1)	FIRST ORDER LAG TIME CONSTANT OF THE TORQUE, SEC
H 66	0.0	TAUT(2)	FIRST ORDER LAG TIME CONSTANT OF THE TORQUE, SEC
H 67	0.0	TAUT(3)	FIRST ORDER LAG TIME CONSTANT OF THE TORQUE, SEC
H 68	4.363E-3	TDEAD(1)	ONE HALF THE TOTAL DEADBAND (RAD)
H 69	4.363E-3	TDEAD(2)	ONE HALF THE TOTAL DEADBAND (RAD)
H 70	4.363E-3	TDEAD(3)	ONE HALF THE TOTAL DEADBAND (RAD)
H 71	444.822	TORQ(1)	REACTION CONTROL THRUST (N)
H 72	444.822	TORQ(2)	REACTION CONTROL THRUST (N)
H 73	444.822	TORQ(3)	REACTION CONTROL THRUST (N)
H 74	2.0574	TSAT(1)	REACTION CONTROL MOMENT ARM (M)
H 75	.90169	TSAT(2)	REACTION CONTROL MOMENT ARM (M)
H 76	.90169	TSAT(3)	REACTION CONTROL MOMENT ARM (M)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** PLOT INPUTS
I 1	1	NCASE	CASE NUMBER TO BE PLOTTED
I 2	9	NUTPUT	TYPE OF OUTPUT FLAG NUTPUT=9 HARD COPY OUTPUT ONLY NUTPUT=16 MICROFILM OUTPUT ONLY NUTPUT=916 BOTH OF THE ABOVE.
I 3	15	NUNIT	TAPE UNIT OF INPUT DATA TAPE
I 4	1	IDEP	NUMBER OF DEPENDENT VARIABLES TO BE PLOTTED.
I 5	0.0	START	START OF INDEPENDENT VARIABLE PLOT OUTPUT
I 6	17000.	STOP	STOP OF INDEPENDENT VARIABLE PLOT OUTPUT
I 7	60.	DELTA	MINIMUM X-AXIS INTERVAL BETWEEN SUCCESSIVELY PLOTTED DATA POINTS. IF DELTA=0.0 ALL DATA POINTS WITHIN THE DESIRED INTERVAL WILL BE PLOTTED.
I 8	0	IRECTP	PROGRAM SEG TO BE PLOTTED. THE DATA CALCULATED LAST IS ALWAYS PLOTTED. IRECTP GREATER THAN ZERO (0), PLOTS THE DATA FROM THE SPECIFIED SECTION (SEGMENT) OF THE PROGRAM. IRECTP EQUAL TO ZERO (0), PLOTS THE DATA FROM ALL SECTIONS (SEGMENTS). IRECTP=4, PLOT TERMINAL MANEUVER, IRECTP=6, PLOT PROPORTIONAL GUIDANCE
I 9	1	ITYP(1)	TYPE OF MATH. MANIPULATION TO BE PERFORMED TO OBTAIN THE INDEPENDENT VARIABLE ITYP(1)=1, NO MANIPULATION ITYP(1)=2, ADD V2 TO V1 V=V1 + V2 ITYP(1)=3, SUBTRACT V2 FROM V1 V=V1 - V2 ITYP(1)=4, MULTIPLY V1 BY V2 V=V1 * V2 ITYP(1)=5, DIVIDE V1 BY V2 V=V1 / V2
I 10-15	1	ITYP(I) I=2-6	TYPE OF MATH. MANIP. TO BE PERF. FOR DEPENDENT VARIABLES, SAME AS ABOVE.
I 19	1	LOC1(1)	INDEPENDENT VARIABLE FROM TABLE
I 20	2	LOC1(2)	FIRST DEPENDENT VARIABLE FROM TABLE
I 21-25	0	LOC1(I) I=3-7	ADDITIONAL DEPENDENT VARIABLES FROM TABLE THERE ARE IDEP + 1 LOC1'S

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			V1 LOCATION TABLE
			LOC1(I)=1 TIME,SEC
			LOC1(I)=2 SLANT RANGE, M
			LOC1(I)=3 RANGE RATE, M /SEC
			LOC1(I)=4 ELEVATION,RAD
			LOC1(I)=5 AZIMUTH, RAD
G 160	0	IKK	LOS RATE TO BE PLOTED
			0 OR 1=FILTERED NOISE
			2=UNFILTERED NOISE
			3=PURE LOS RATE
			LOC1(I)=6 LOS RATE ELEV., RAD/SEC
			LOC1(I)=7 LOS RATE AZIM., RAD/SEC
			RELATIVE TO TUG
			LOC1(I)=8 IT RANGE, M .
			LOC1(I)=9 CT RANGE, M .
			LOC1(I)=10 RAD RANGE, M
			LOC1(I)=11 IT VELOCITY, M /SEC
			LOC1(I)=12 CT VELOCITY, M /SEC
			LOC1(I)=13 RAD VELOCITY, M /SEC
			LOC1(I)=14 TOT IMPULSE REMAINING, MAIN TANK
			LOC1(I)=16 TOTAL IMPULSE REMAING, APS TANK
			LOC1(I)=17 TOTAL IMPULSE, ATTITUDE CONTROL SUBSYSTEM
G 150	0	IDIMY(480)	SELECT BODY OR EULER ANGLES FOR PLOTING
			0 IS BODY, 1 IS EULER
			LOC1(I)=18 VEHICLE PITCH ATTITUDE, RAD
			LOC1(I)=19 VEHICLE YAW ATTITUDE, RAD
			LOC1(I)=20 VEHICLE ROLL ATTITUDE, RAD
			LOC1(I)=21 VEHICLE PITCH RATE, RAD/SEC
			LOC1(I)=22 VEHICLE YAW RATE, RAD/SEC
			LOC1(I)=23 VEHICLE ROLL RATE, RAD/SEC
			EARTH CENTERED COORDINATE SYSTEM
			LOC1(I)=24 X, M
			LOC1(I)=25 Y, M
			LOC1(I)=26 Z, M
			LOC1(I)=27 X RATE, M /SEC
			LOC1(I)=28 Y RATE, M /SEC
			LOC1(I)=29 Z RATE, M /SEC
			LOC1(I)=30 ALTITUDE, KM .
			LOC1(I)=31 APS TRANSLATIONAL THRUST NUMBER
			LOC1(I)=32 SLANT RANGE, KM .
			LOC1(I)=33 INERTIAL VELOCITY, M /SEC

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
I 29-35	0	LOC2(J)	V2 LOCATION CORRESPONDING TO ITYP(J). IF LOC2(J)=0, THEN CONST(J) WILL BE USED AS V2. SEE V1 LOCATION TABLE FOR V2 LOCATION.
I 39-45	0.0	CONST(J)	CONSTANT VALUE TO BE USED AS V2, CORRESPONDING TO ITYP(J)
			***THE FOLLOWING INPUTS ENABLES SPECIFICATION OF PLOT SCALING. (NO OTHER ADJUSTMENT IS MADE.) QMAX AND QMIN SPECIFY THE UPPER AND LOWER BOUNDS OF THE Y-AXIS, WHILE MULT ARE INTEGER MULTIPLICATION FACTORS. ** THIS PERFORMS INTEGER MULTIPLICATION AND FIXED SCALING OF ALL CURVES. QMIN,AND QMAX MUST NOW BE SPECIFIED ** IF ALL FACTORS ARE ZERO SCALING IS OBTAINED FROM DATA.
I 51-54	0	MULT(I)	MULTIPICATIVE FACTORS FOR SCALING DATA VALUES. IF ANY OF FACTORS ARE NON-ZERO, THEN ALL ZERO INPUTS ARE USED AS UNITY (1). IF ALL FACTORS ARE ZERO, THE MULTIPLICATIVE FACTORS ARE COMPUTED.
I 55	0.0	QMIN	MINIMUM Y-AXIS PLOT SCALING VALUE.
I 56	0.0	QMAX	MAXIMUM YAXIS PLOT SCALING VALUE.
			** TITLE
I 57-68		TITLE	TITLE OF PLOT.
I 70	0		PRINTS MIN. SR. AND TIME ON PLOTS IF=1

LOCDOK

INPUT DICTIONARY

(ENGLISH UNITS)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** MAIN PROGRAM CONTROLS

*** THE FIRST INPUT CARD MUST ALWAYS BE AS FOLLOWS:
A BLANK CARD IF THE UNITS ARE ENGLISH
A 1 PUNCHED IN COLUMN 3 IF THE UNITS ARE SI

			*** DATA CARDS
A 1	1	ICASE	CASE NUMBER
A 5	1	IOUTJW	UNIT OF THE DATA TAPE. IF IOUTJW IS LESS THAN 15, NO DATA TAPE IS GENERATED. THIS DATA TAPE CONTAINS THE SETS OF TIME DEPENDENT DATA, FROM WHICH THE PLOTS ARE GENERATED.
A 6	0	IP	PLOT AND DATA TAPE CONTROL IP=1 GENERATE PLOTS FROM A DATA TAPE IP=0 MAKE A PLOT DATA TAPE IF IOUTJW IS GREATER THAN 14. IF MORE THAN ONE DATA TAPE IS NEEDED,A 5 DOES NOT HAVE TO BE CHANGED, BUT THE EXTRA TAPE UNITS MUST BE ASSIGNED WITH UNIT # = IOUTJW+1. IP=-1 SAME AS IP=0,AND TELLS PROGRAM THAT THIS IS THE LAST CASE TO BE WRITTEN ON DATA TAPE
A 7-18		TITLE	CASE TITLE CARD

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RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** PROGRAM CONTROLS
F 97	0	METRIC	1 IS METRIC, 0 IS ENGLISH
G 3	4	MANUVR	TERMINAL RENDEZVOUS MANEUVER CONTROL IS A LEFT REGISTERED FIVE DIGIT NUMBER. EACH DIGIT IS PROCESSED SEQUENTIALLY. ALL DIGITS NOT SPECIFIED BELOW ARE SKIPPED. DIGIT=4 DOCKING
H 2	400	IPRT4	OUTPUTS DATA EVERY NTH.INTEGRATION STEP
			**TIMING PARAMETERS
G 11	0.0	STIME	PROBLEM STARTING TIME, SECONDS
G 12	17000.	STIMAX	MAXIMUM SYSTEM TIME FOR RUN (SEC) ONLY FOR 1ST TRACKING INTERVAL
G 19	0.3	HFD	TIME BETWEEN DATA POINTS TO COMPUTER (SEC)
G 22	10.	TMIN	MINIMUM TIME ALLOWED FOR TRANSFERS, SEC
G 23	13500.	TMAX1	MAXIMUM ALLOWED TRANSFER TIME, SEC
G 37	120.	DLTORI	TIME ALLOWED FOR ROTATION OF TUG PRIOR TO START OF DOCKING, SEC.
H 1	.01	HPG	INTEGRATION STEP SIZE FOR DETAILED ATTITUDE CONTROL AND BURNS IF HPG = 0.0, THEN HPG IS SET TO HFD
H 89	20.	TDELI	TIME DELAY BEFORE THE START OF P.G., SEC
H 90	0.0	TSWTCH	TIME AT WHICH SECOND SET OF LOS RATE SWITCHING LINES ARE IMPLEMENTED IF TSWTCH IS GREATER THAN ZERO (0), SEC

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** TUG/PAYLOAD INITIAL POSITION AND VELOCITY
G 39	138116180.	RV(1,1)	INERTIAL COORDINATE OF THE TUG (X), FT
G 40	-182283.	RV(2,1)	INERTIAL COORDINATE OF THE TUG (Y), FT
G 41	194636.	RV(3,1)	INERTIAL COORDINATE OF THE TUG (Z), FT
G 42	138310620.	RV(1,2)	INERTIAL COORDINATE OF THE PAYLOAD (X), FT
G 43	0.0	RV(2,2)	INERTIAL COORDINATE OF THE PAYLOAD (Y), FT
G 44	200.	RV(3,2)	INERTIAL COORDINATE OF THE PAYLOAD (Z), FT
			*VELOCITY IN FT/SEC
G 45	27.2939	VV(1,1)	INERTIAL VELOCITY OF THE TUG (XDOT)
G 46	10084.82	VV(2,1)	INERTIAL VELOCITY OF THE TUG (YDOT)
G 47	-14.	VV(3,1)	INERTIAL VELOCITY OF THE TUG (ZDOT)
G 48	0.0	VV(1,2)	INERTIAL VELOCITY OF THE PAYLOAD (XDOT)
G 49	10087.	VV(2,2)	INERTIAL VELOCITY OF THE PAYLOAD (YDOT)
G 50	0.0	VV(3,2)	INERTIAL VELOCITY OF THE PAYLOAD (ZDOT)

IF THE TUG STATE IS DESIRED TO BE INPUT RELATIVE TO THE PAYLOAD THEN G 39, G 40, AND G 41 BECOME DELTA CROSS TRACK, DELTA RADIAL, AND DELTA IN TRACK. G 45, G 46, G 48 BECOMES DELTA CT DOT, DELTA R DOT, AND DELTA IT DOT.
RELATIVE POSITIONS ARE ASSUMED IF THE RMS OF THE THREE RANGE INPUTS IS LESS THAN THE EQUITORIAL RADIUS.
THE DELTAS ARE ADDED TO THE PAYLOAD ORBIT TO OBTAIN THE TUG ORBIT.

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			**MASS PROPERTIES
G 18	21.229	AUXFUL	APS PROPELLANT MASS (SLUGS)
G 51	160.4348	FMBS	TUG DRY MASS (SLUGS)
G 52	826.21	FMFS	TUG MAIN ENG PROPELLANT MASS (SLUGS)
			**PROPULSION
G 13	2.5	FJSUBT	MIN IMPULSE BIT LATERAL ENG. (LB-SEC)
G 16	.5	TOIU	TAIL OFF UNCERTAINTY OF LAT. ENG. (LB-SEC)
G 53	3200.0	DELJM	TAIL-OFF IMPULSE OF MAIN ENGINE. (LB-SEC)
G 54	5.0	DELJS	TAIL-OFF IMPULSE OF THE AXIAL SECONDARY ENGINES (LB-SEC)
G 55	1500.0	FJSUBM	MINIMUM IMPULSE OF MAIN ENGINE. LB-SEC
G 56	2.5	FJSUBS	MINIMUM IMPULSE OF THE AXIAL SECONDARY ENGINES (LB-SEC)
G 57	230.0	FIST	SPECIFIC IMPULSE OF THE LATERAL ENGINES (SEC)
G 58	444.0	FIMS	SPECIFIC IMPULSE OF MAIN ENGINE (SIM) SEC
G 59	230.0	FISS	SPECIFIC IMPULSE OF THE AXIAL SECONDARY ENGINES (SEC)
G 60	0.	FKVB	PERCENT ERROR IN BURN MAGNITUDES
G 61	15000.	TMS	MAIN ENGINE THRUST LEVEL, LB
G 62	100.0	TSS	THRUST LEVEL OF THE AXIAL SECONDARY ENGINES (POUNDS), LOS ENG
G 63	100.	TST	THRUST LEVEL OF THE LATERAL ENGINES (LBS)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** NOISE AND ERROR PARAMETERS
G 2	1	KONTAM	KONTAM INITIALIZES NOISE GENERATOR.0 DOESNT
			*** FOR ZERO NOISE SET STD(I) TO 0.0
			(1),(2)=RANGE (FT) (3),(4)=RANGE RATE (FT/SEC) (5),(6)=ELEVATION RATE LOS (RAD/SEC) (7),(8)=AZIMUTH RATE LOS (RAD/SEC)
H 4-11	314.159	BANDW(I)	BANDWIDTH OF THE 8 COLORED NOISE GENERATORS IN RAD/SEC
H 12-19	1.0	CSTAR(I)	COEFFICIENTS OF THE NOISE TERMS
			EXPONENTS OF THE NOISE TERMS
H 20	1.0	EXPON(1)	
H 21	0.0	EXPON(2)	
H 22	1.0	EXPON(3)	
H 23	0.0	EXPON(4)	
H 24	1.0	EXPON(5)	
H 25	-1.	EXPON(6)	
H 26	1.0	EXPON(7)	
H 27	-1.	EXPON(8)	
H 28-35	1.	RLWR(I)	LOWER BREAK POINT FOR 8 RANGE DEPENDENT NOISE PARAMETERS, (FT)
H 36-43	471506.56	RUPR(I)	UPPER BREAK POINT FOR RANGE 8 DEPENDENT NOISE PARAMETERS, (FT)
			STANDARD DEVIATIONS OF THE 8 NOISE GENERATORS
H 44	23.8355	STD(1)	
H 45	0.0	STD(2)	
H 46	0.0	STD(3)	
H 47	0.0	STD(4)	
H 48	0.0	STD(5)	
H 49	0.0	STD(6)	
H 50	0.0	STD(7)	
H 51	0.0	STD(8)	

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			TO SET NOISE TO ZERO, JUST SET SIGSR(I) TO 0.0
		(3),(4)	AZIMUTH (RAD)
		(5),(6)	ELEVATION (RAD)
			COEFFICIENTS OF NOISE TERMS
G 73	1.	BSTAR(3)	
G 74	1.	BSTAR(4)	
G 75	1.	BSTAR(5)	
G 76	1.	BSTAR(6)	
			EXPONENT OF NOISE TERMS
G 79	1.	P(3)	
G 80	-1.	P(4)	
G 81	1.	P(5)	
G 82	-1.	P(6)	
			UPPER BREAK-POINTS FOR RANGE DEPENDENT NOISE, FT
G 85-88	471506.565	RU(I)	I = 3 TO 6
			LOWER BREAK-POINTS FOR RANGE DEPENDENT NOISE, FT
G 91-94	1.	RL(I)	I = 3 TO 6
			STANDARD DEVIATIONS OF THE NOISE GENERATORS.
G 97	2.90855E-4	SIGSR(3)	
G 98	1.30878E-7	SIGSR(4)	
G 99	2.90855E-4	SIGSR(5)	
G 100	1.30878E-7	SIGSR(6)	
			* BANDWIDTHS OF THE 4 COLORED-NOISE GENERATORS (RADIANS/SECOND)
G 106-109	314.1594	OMEGSR(I)	FOR I= 3-6
			**SINUSOIDAL NOISE
G 146	0.	GG1(1)	EL RATE FREQ. (HERTZ)
G 147	0.	GG1(2)	AZ RATE FREQ. (HERTZ)
G 148	0.	GG1(3)	EL RATE MAX AMPLITUDE (RAD/SEC)
G 149	0.	GG1(4)	AZ RATE MAX AMPLITUDE (RAD/SEC)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** SENSOR PARAMETERS
F 44	16.	PRF	BASIC SENSOR MEASUREMENT REPETITION RATE, MEASUREMENTS PER SECOND
F 98	77.6	SACQL	ACQ. RANGE OF DOCKING SENSOR (N. MI)
G 15	30.	RITASP	1/2 ACCEPTANCE ANGLE OF DOCKING AID (DEG)
			** RESOLUTION AND BIAS ERRORS OF SENSOR
D 29	0.	SIGMA(1)	RESOLUTION IN RANGE RATE,FT/SEC
D 30	0.	SIGMA(2)	RESOLUTION IN AZIMUTH RATE, DEG/SEC
D 31	0.	SIGMA(3)	RESOLUTION IN ELEVATION RATE, DEG/SEC
D 33	.3	SIGMB(1)	RANGE RESOLUTION IN FEET.
D 34	0.0025	SIGMB(2)	AZIMUTH RESOLUTION IN DEGREES.
D 35	0.0025	SIGMB(3)	ELEVATION RESOLUTION IN DEGREES.
H 52	0.0	DELSB	RANGE BIAS, (FT)
H 53	0.0	DLSDB	RANGE RATE BIAS, (FT/SEC)
G 113	0.	DELAZB	AZIMUTH BIAS ERROR, RAD
G 114	0.	DELELB	ELEVATION BIAS ERROR, RAD
H 54	0.0	DLOMZB	ELEVATION RATE BIAS, (RAD/SEC)
H 55	0.0	DLOMYB	AZIMUTH RATE BIAS, (RAD/SEC)
H 93	0	ISEN	TYPE OF SENSOR USED 0=GIMBALLED 1=BODY FIXED

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			***GUIDANCE PARAMETERS
G 17	3.	DAMP	EXPONENT FOR DOCKING AXIS GUIDANCE
H 77	1.E+10	FK(1)	THE PROPORTIONALITY CONSTANT THAT SWITCHES THE AXIAL ENGINES ON
H 78	0.0	FK(2)	THE PROPORTIONALITY CONSTANT THAT SWITCHES THE AXIAL ENGINES OFF
H 79	4.E+5	RSUBB(1)	STANDOFF RANGE FOR MAIN ENGINE, FT
H 80	13.7	RSUBB(2)	STANDOFF RANGE FOR APS ENGINE, FT
H 81	3.E-5	OMHI	THE LOS RATE ABOVE WHICH A LATERAL THRUST IS ON (RAD/SEC)
H 82	1.E-5	OMLO	THE LOS RATE BELOW WHICH A LATERAL THRUST IS OFF (RAD/SEC)
H 83	4.0	PROCON	THE NAVIGATION CONSTANT
H 84	13.7	RSUBF	THE RANGE AT WHICH P.G. IS TERMINATED, FT
H 85	0.01	RSUBFD	THE RANGE RATE AT WHICH P.G.IS TERMINATED (FT/SEC)
H 91	1.E-3	OMLO2	ALTERNATE VALUE OF OMLO AT TSWTCH, RAD/SEC
H 92	3.E-3	OMHI2	ALTERNATE VALUE OF OMHI AT TSWTCH, RAD/SEC
			*** DATA FILTERING
G 6	100	NSUBF	NUMBER OF DATA POINTS TO BE USED IN DATA FITTING.
G 14	1	KSWICH	0 IS LINEAR DATA FILTER, 1 IS KALMAN
H 86	0.0	TAUDA(1)	TIME CONSTANT OF GUID LOW-PASS FILTER, RANGE (SEC)
H 87	0.0	TAUDA(2)	TIME CONSTANT OF GUID LOW-PASS FILTER RANGE RATE (SEC)
H 88	0.0	TAUDA(3)	TIME CONSTANT OF GUID LOW-PASS FILTER, LOS RATE (SEC)
H 100	0	IFILT	TYPE OF GUIDANCE FILTER 0=SINGLE ORDER LOW PASS 1=6 POLE BUTTERWORTH
			*** ABORT PARAMETERS
D 55	3600.	TI	TIME ELAPSED TO START DOCKING APPROACH AFTER ABORT (SEC)
D 56	33.34	PW	WIDTH OF PAYLOAD (FT)
D 57	20.	YSAFTY	CLEARANCE BELOW PAYLOAD REQUIRED FOR AN ABORT (FT)
D 58	16.67	YC	PAYLOAD LENGTH BELOW DOCKING AXIS (FT)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			***DOCKING PARAMETERS
			*** ACCURACY REQUIREMENTS AT ABORT RANGE ***
F 88	.5	TOLPOS(1)	POSITION ALONG DOCKING AXIS (FT)
F 89	.7083	TOLPOS(2)	POSITION NORMAL TO DOCKING AXIS (FT)
F 90	.7083	TOLPOS(3)	POSITION NORMAL TO DOCKING AXIS (FT)
F 91	.013	TOLVEL(1)	VELOCITY ALONG DOCKING AXIS (FT/SEC)
F 92	.013	TOLVEL(2)	VELOCITY NORMAL TO DOCKING AXIS (FT/SEC)
F 93	.013	TOLVEL(3)	VELOCITY NORMAL TO DOCKING AXIS (FT/SEC)
F 94	3.0	TOLANG(1)	ROLL ANGLE (DEG)
F 95	3.0	TOLANG(2)	YAW ANGLE (DEG)
F 96	3.0	TOLANG(3)	PITCH ANGLE (DEG)
G 116	.2	DMIN	MINIMUM TRANSFER LENGTH BELOW WHICH A NEW TRANSFER IS NOT STARTED
			DISPLACEMENT OF DOCKING SENSOR BORE-SIGHT TO DOCKING MECHANISM CENTER-LINE
G 117	0.	G(117)	DESIRED FINAL IN-TRACK POSITION, FT
G 118	0.	G(118)	DESIRED FINAL RADIAL POSITION, FT
G 119	0.	G(119)	DESIRED FINAL CROSS-TRACK POSITION, FT
G 123	20.	RSUBMT	MISS DISTANCE THRESHOLD IN GROSS-TRANSFERS, (FEET)
G 124	-1.	UNR2(1)	DIRECTION COSINE OF DESIRED DOCKING AXIS (IT)
G 125	0.	UNR2(2)	DIRECTION COSINE OF DESIRED DOCKING AXIS (RAD)
G 126	0.	UNR2(3)	DIRECTION COSINE OF DESIRED DOCKING AXIS (CT)
G 127	13.7	RSUBD	RANGE IN DOCKING MANEUVERS WHERE CLOSING VELOCITY SWITCHES TO DOCKING VELOCITY (FT) THIS IS ALSO THE ABORT RANGE
G 130	1000.	R2MIN	MINIMUM DISTANCE ON THE DOCKING AXIS WHERE A FINAL DOCKING APPROACH COULD BE STARTED, FT
G 131	5.	VDD	VEL PARALLEL TO THE DOCKING AXIS (FT/SEC)
G 132	0.5	VDOCK	MAGNITUDE OF DESIRED FINAL IMPACT VELOCITY IN DOCKING MANEUVERS, FT/SEC.

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			***ATTITUDE CONTROL PARAMETERS (1)=ROLL, (2)=YAW, (3)=PITCH
G 151	1		ATTITUDE CONTROL SYSTEM SELECTION 0=DETAILED, 1=PERFECT
			MIN ANG IMPULSE BIT REACTION CONTROL SYS
G 157	16.875	SEN(6)	ROLL (FT-LB-SEC)
G 158	7.3958	SEN(7)	YAW (FT-LB-SEC)
G 159	7.3958	SEN(8)	PITCH (FT-LB-SEC)
H 56	5279.	INERT(1)	PRINCIPLE MOMENTS OF INERTIA OF THE TUG (FT-LB-SEC2)
H 57	43217.	INERT(2)	PRINCIPLE MOMENTS OF INERTIA OF THE TUG (FT-LB-SEC2)
H 58	43448.	INERT(3)	PRINCIPLE MOMENTS OF INERTIA OF THE TUG (FT-LB-SEC2)
H 59	7.862	FKGA(1)	ATTITUDE POSITION GAIN CONSTANT
H 60	146.937	FKGA(2)	ATTITUDE POSITION GAIN CONSTANT
H 61	147.624	FKGA(3)	ATTITUDE POSITION GAIN CONSTANT
H 62	157.24	FKGD(1)	ATTITUDE RATE GAIN CONSTANT
H 63	2936.74	FKGD(2)	ATTITUDE RATE GAIN CONSTANT
H 64	2952.48	FKGD(3)	ATTITUDE RATE GAIN CONSTANT
H 65	0.0	TAUT(1)	FIRST ORDER LAG TIME CONSTANT OF THE TORQUE, SEC
H 66	0.0	TAUT(2)	FIRST ORDER LAG TIME CONSTANT OF THE TORQUE, SEC
H 67	0.0	TAUT(3)	FIRST ORDER LAG TIME CONSTANT OF THE TORQUE, SEC
H 68	4.363E-3	TDEAD(1)	ONE HALF THE TOTAL DEADBAND (RAD)
H 69	4.363E-3	TDEAD(2)	ONE HALF THE TOTAL DEADBAND (RAD)
H 70	4.363E-3	TDEAD(3)	ONE HALF THE TOTAL DEADBAND (RAD)
H 71	100.	TORQ(1)	REACTION CONTROL THRUST (LBS)
H 72	100.	TORQ(2)	REACTION CONTROL THRUST (LBS)
H 73	100.	TORQ(3)	REACTION CONTROL THRUST (LBS)
H 74	6.75	TSAT(1)	REACTION CONTROL MOMENT ARM (FT)
H 75	2.9583	TSAT(2)	REACTION CONTROL MOMENT ARM (FT)
H 76	2.9583	TSAT(3)	REACTION CONTROL MOMENT ARM (FT)

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
			*** PLOT INPUTS
I 1	1	NCASE	CASE NUMBER TO BE PLOTTED
I 2	9	NUTPUT	TYPE OF OUTPUT FLAG NUTPUT=9 HARD COPY OUTPUT ONLY NUTPUT=16 MICROFILM OUTPUT ONLY NUTPUT=916 BOTH OF THE ABOVE.
I 3	15	NUNIT	TAPE UNIT OF INPUT DATA TAPE
I 4	1	IDEP	NUMBER OF DEPENDENT VARIABLES TO BE PLOTTED.
I 5	0.0	START	START OF INDEPENDENT VARIABLE PLOT OUTPUT
I 6	17000.	STOP	STOP OF INDEPENDENT VARIABLE PLOT OUTPUT
I 7	60.	DELTA	MINIMUM X-AXIS INTERVAL BETWEEN SUCCESSIVELY PLOTTED DATA POINTS. IF DELTA=0.0 ALL DATA POINTS WITHIN THE DESIRED INTERVAL WILL BE PLOTTED.
I 8	0	IRECTP	PROGRAM SEG TO BE PLOTTED. THE DATA CALCULATED LAST IS ALWAYS PLOTTED. IRECTP GREATER THAN ZERO (0), PLOTS THE DATA FROM THE SPECIFIED SECTION (SEGMENT) OF THE PROGRAM. IRECTP EQUAL TO ZERO (0), PLOTS THE DATA FROM ALL SECTIONS (SEGMENTS). IRECTP=4, PLOT TERMINAL MANEUVER, IRECTP=6, PLOT PROPORTIONAL GUIDANCE
I 9	1	ITYP(1)	TYPE OF MATH. MANIPULATION TO BE PERFORMED TO OBTAIN THE INDEPENDENT VARIABLE ITYP(1)=1, NO MANIPULATION ITYP(1)=2, ADD V2 TO V1 V=V1 + V2 ITYP(1)=3, SUBTRACT V2 FROM V1 V=V1 - V2 ITYP(1)=4, MULTIPLY V1 BY V2 V=V1 * V2 ITYP(1)=5, DIVIDE V1 BY V2 V=V1 / V2
I 10-15	1	ITYP(I) I=2-6	TYPE OF MATH. MANIP. TO BE PERF. FOR DEPENDENT VARIABLES, SAME AS ABOVE.
I 19	1	LOC1(1)	INDEPENDENT VARIABLE FROM TABLE
I 20	2	LOC1(2)	FIRST DEPENDENT VARIABLE FROM TABLE
I 21-25	0	LOC1(I) I=3-7	ADDITIONAL DEPENDENT VARIABLES FROM TABLE THERE ARE IDEP + 1 LOC1'S

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE	
			V1 LOCATION TABLE	
			LOC1(I)=1	TIME,SEC
			LOC1(I)=2	SLANT RANGE, FT
			LOC1(I)=3	RANGE RATE, FT/SEC
			LOC1(I)=4	ELEVATION,DEG
			LOC1(I)=5	AZIMUTH, DEG
G 160	0	IKK	LOS RATE TO BE PLOTED 0 OR 1=FILTERED NOISE 2=UNFILTERED NOISE 3=PURE LOS RATE	
			LOC1(I)=6	LOS RATE ELEV., RAD/SEC
			LOC1(I)=7	LOS RATE AZIM., RAD/SEC
				RELATIVE TO TUG
			LOC1(I)=8	IT RANGE, FT.
			LOC1(I)=9	CT RANGE, FT.
			LOC1(I)=10	RAD RANGE, FT
			LOC1(I)=11	IT VELOCITY, FT/SEC
			LOC1(I)=12	CT VELOCITY, FT/SEC
			LOC1(I)=13	RAD VELOCITY, FT/SEC
			LOC1(I)=14	TOT IMPULSE REMAINING, MAIN TANK
			LOC1(I)=16	TOTAL IMPULSE REMAING, APS TANK
			LOC1(I)=17	TOTAL IMPULSE, ATTITUDE CONTROL SUBSYSTEM
G 150	0	IDIMY(480)	SELECT BODY OR EULER ANGLES FOR PLOTING 0 IS BODY, 1 IS EULER	
			LOC1(I)=18	VEHICLE PITCH ATTITUDE, DEG
			LOC1(I)=19	VEHICLE YAW ATTITUDE, DEG
			LOC1(I)=20	VEHICLE ROLL ATTITUDE, DEG
			LOC1(I)=21	VEHICLE PITCH RATE, DEG/SEC
			LOC1(I)=22	VEHICLE YAW RATE, DEG/SEC
			LOC1(I)=23	VEHICLE ROLL RATE, DEG/SEC
				EARTH CENTERED COORDINATE SYSTEM
			LOC1(I)=24	X, FT
			LOC1(I)=25	Y, FT
			LOC1(I)=26	Z, FT
			LOC1(I)=27	X RATE, FT/SEC
			LOC1(I)=28	Y RATE, FT/SEC
			LOC1(I)=29	Z RATE, FT/SEC
			LOC1(I)=30	ALTITUDE, N.MI.
			LOC1(I)=31	APS TRANSLATIONAL THRUST NUMBER
			LOC1(I)=32	SLANT RANGE, N.MI.
			LOC1(I)=33	INERTIAL VELOCITY, FT/SEC

RELATIVE ADDRESS	PRESET VALUE	FORTRAN NAME	PURPOSE
I 29-35	0	LOC2(J)	V2 LOCATION CORRESPONDING TO ITYP(J). IF LOC2(J)=0, THEN CONST(J) WILL BE USED AS V2. SEE V1 LOCATION TABLE FOR V2 LOCATION.
I 39-45	0.0	CONST(J)	CONSTANT VALUE TO BE USED AS V2, CORRESPONDING TO ITYP(J)
			***THE FOLLOWING INPUTS ENABLES SPECIFICATION OF PLOT SCALING. (NO OTHER ADJUSTMENT IS MADE.) QMAX AND QMIN SPECIFY THE UPPER AND LOWER BOUNDS OF THE Y-AXIS, WHILE MULT ARE INTEGER MULTIPLICATION FACTORS. ** THIS PERFORMS INTEGER MULTIPLICATION AND FIXED SCALING OF ALL CURVES. QMIN,AND QMAX MUST NOW BE SPECIFIED ** IF ALL FACTORS ARE ZERO SCALING IS OBTAINED FROM DATA.
I 51-54	0	MULT(I)	MULTIPICATIVE FACTORS FOR SCALING DATA VALUES. IF ANY OF FACTORS ARE NON-ZERO, THEN ALL ZERO INPUTS ARE USED AS UNITY (1). IF ALL FACTORS ARE ZERO, THE MULTIPLICATIVE FACTORS ARE COMPUTED.
I 55	0.0	QMIN	MINIMUM Y-AXIS PLOT SCALING VALUE.
I 56	0.0	QMAX	MAXIMUM YAXIS PLOT SCALING VALUE.
			** TITLE
I 57-68		TITLE	TITLE OF PLOT.
I 70	0		PRINTS MIN. SR. AND TIME ON PLOTS IF=1